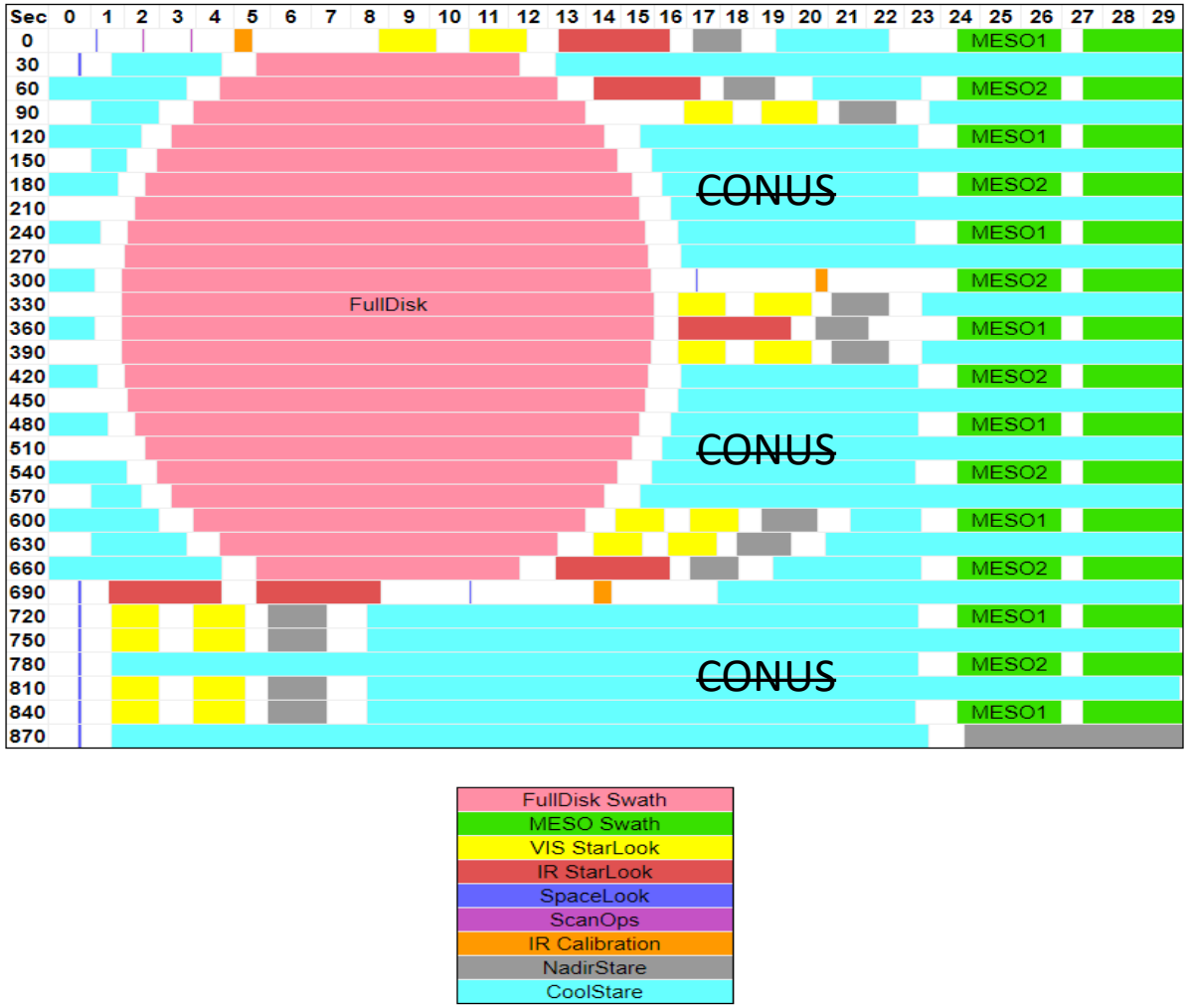
Evaluation of Cooling Operation

GOES-R Calibration Working Group (CWG)

2020-05-13

Introduction

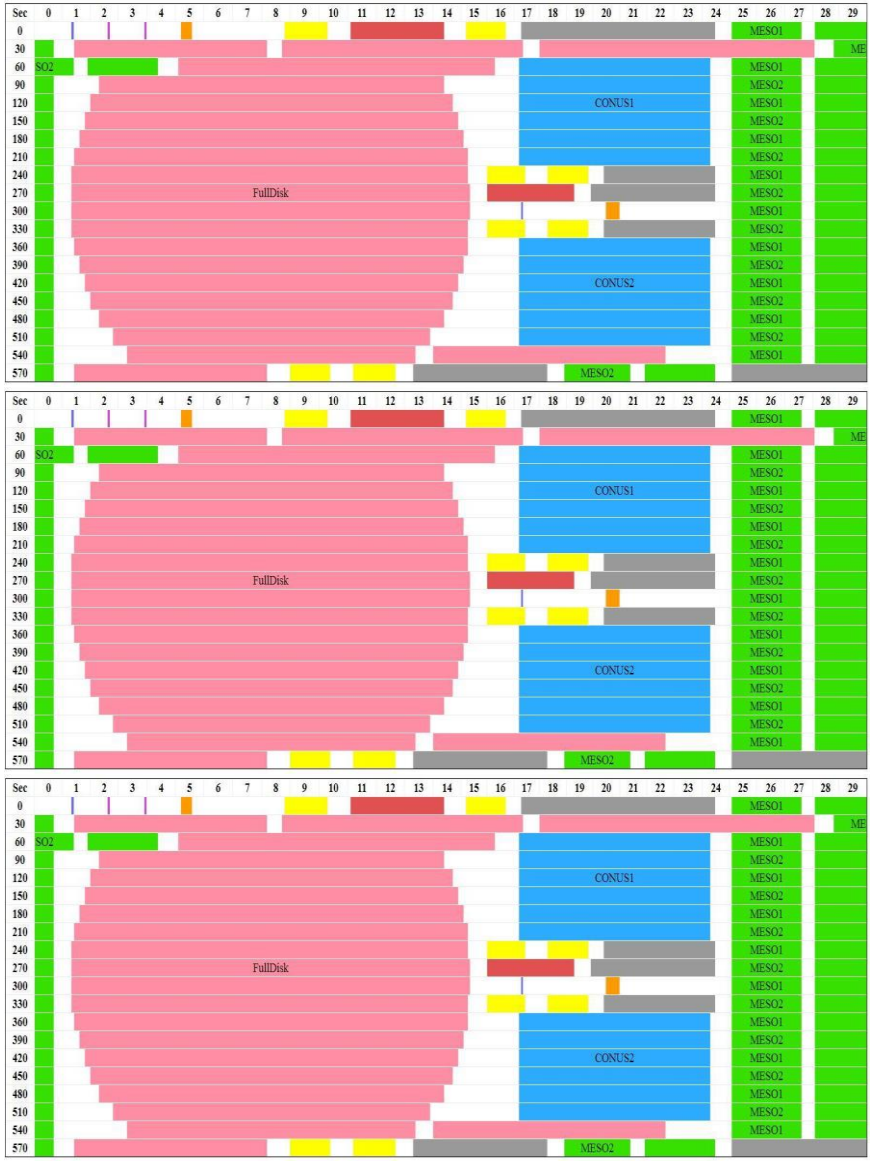
- GOES-17 ABI LHP anomaly imposes a daily period of lost imagery when the FPM is too hot.
- Cooling operation shortens that period by using the ABI less for earth viewing and more for cooling to slow down the FPM heating.
- It uses the timeline to the right when the heating is intense:
  - 0600 – 1200 UTC.
  - 4/9 – 5/1; 8/12 – 9/1; 10/14 – 31; …
- Evaluation: Has the operation:
  - Reduced the FPM temperature?
  - Shortened the period of lost imagery?

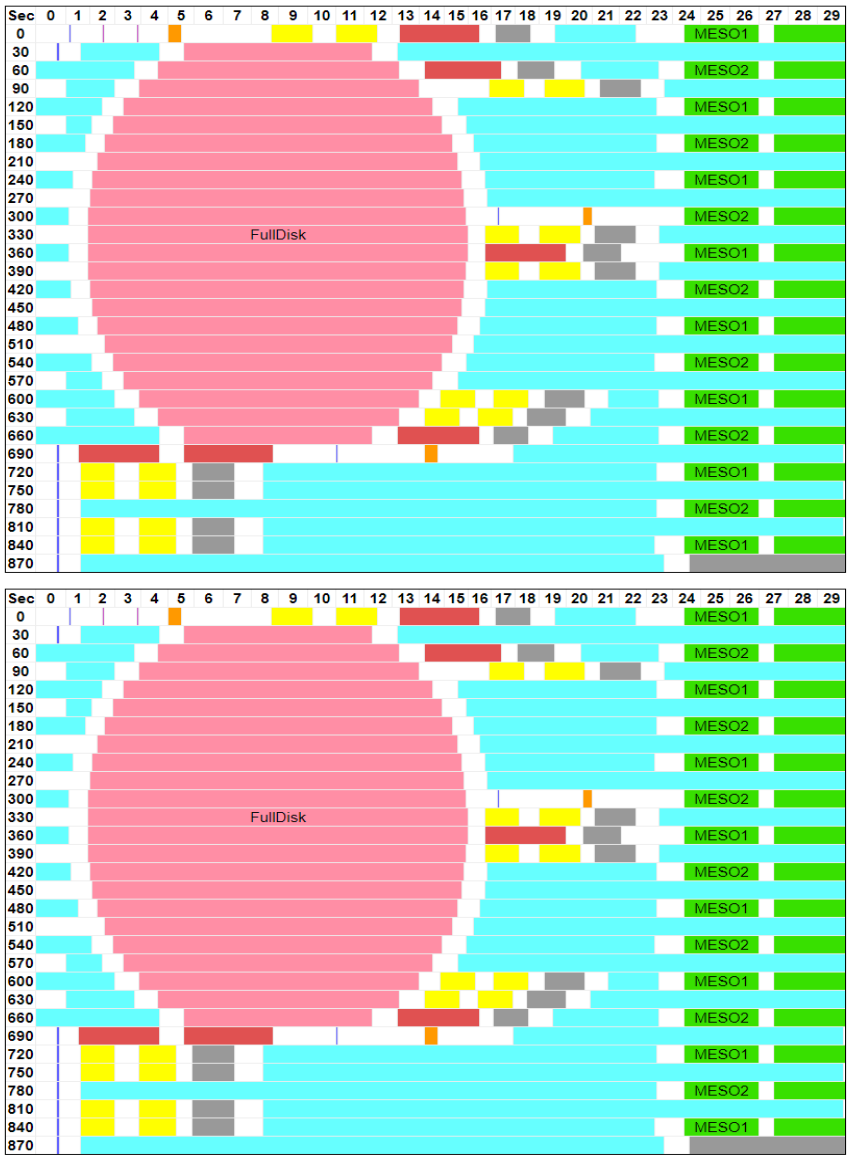


Modified from https://www.ospo.noaa.gov/Operations/GOES/west/Mode3G_Cooling_Timeline_G17.html

Cooling Operations for GOES-17

FD: 3 to 2
CONUS: 6 to 0
MESO: 60 to 30

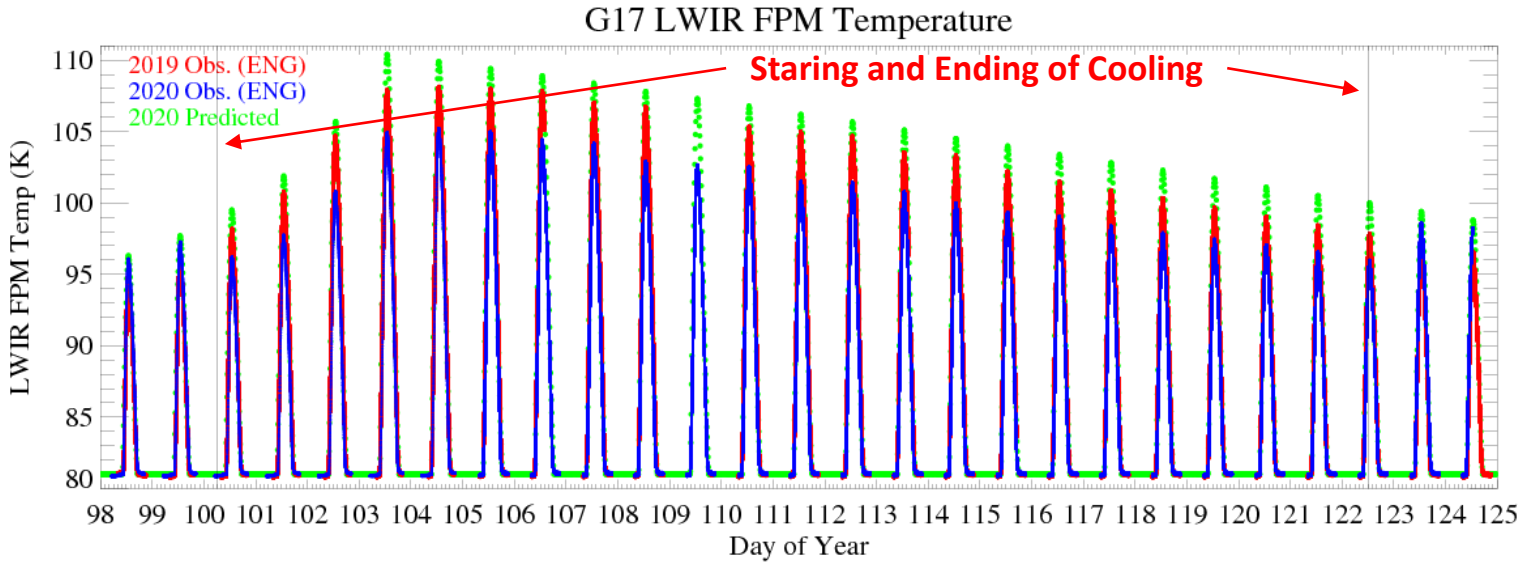




Replaces three nominal Mode 6 Timelines with two Cooling Timelines.

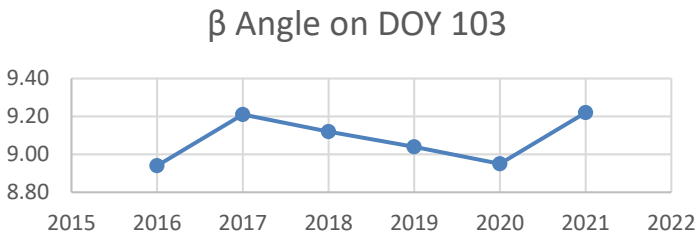
IMPACT ON FPM TEMPERATURE

LWIR

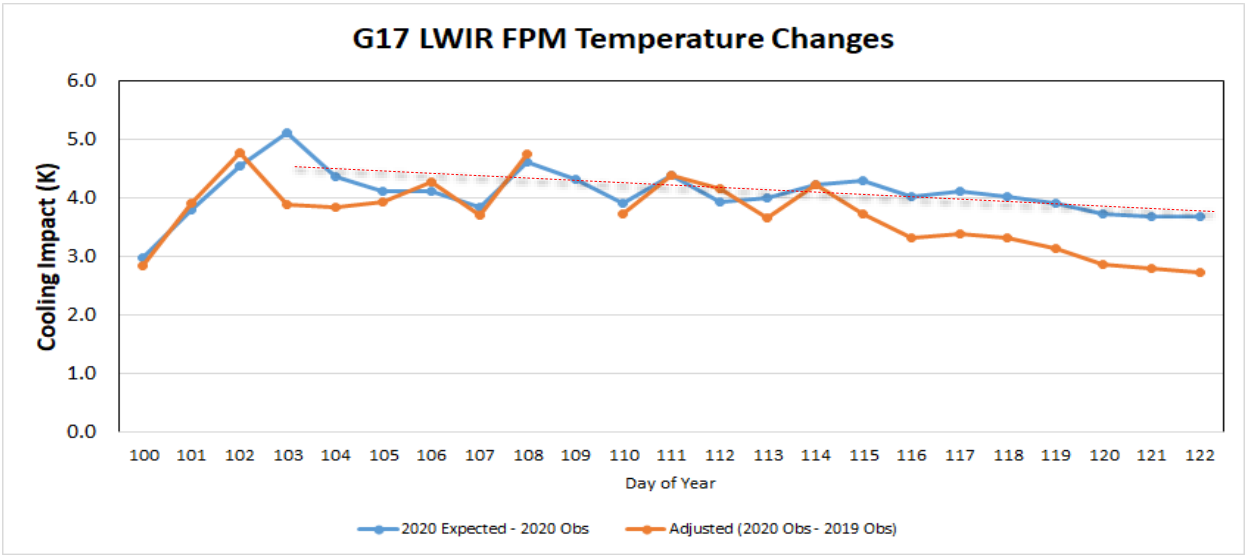


Why 1K warmer?

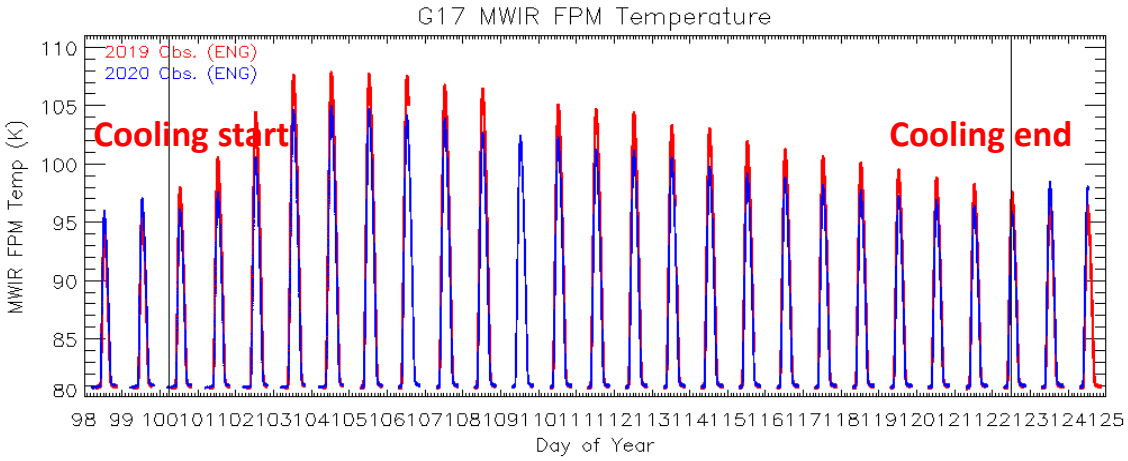
- A quarter day difference on the same DOY in terms of β angle.
- MESO location etc.
- Cooling capacity.

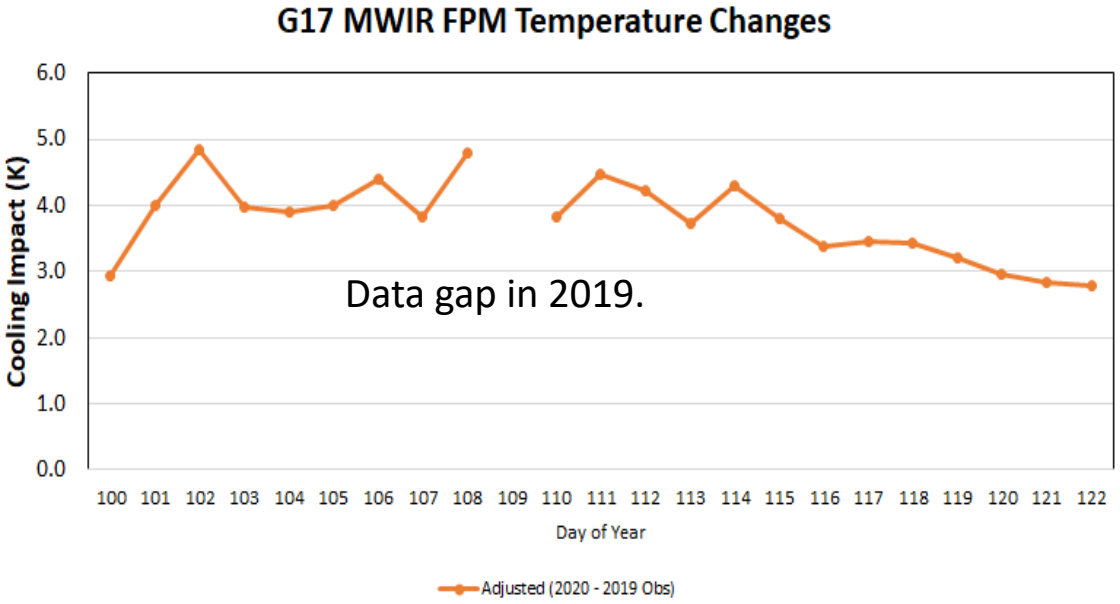


- Time series of 2020 Prediction (without cooling), 2020 Actual, and 2019 Actual.
- 1K warmer than 2019 when or if no cooling (green vs. red).
- Reduced the daily peak temperature by ~4K (green vs. blue).
- Slightly larger reduction on warmer days.
- All as expected.



MWIR



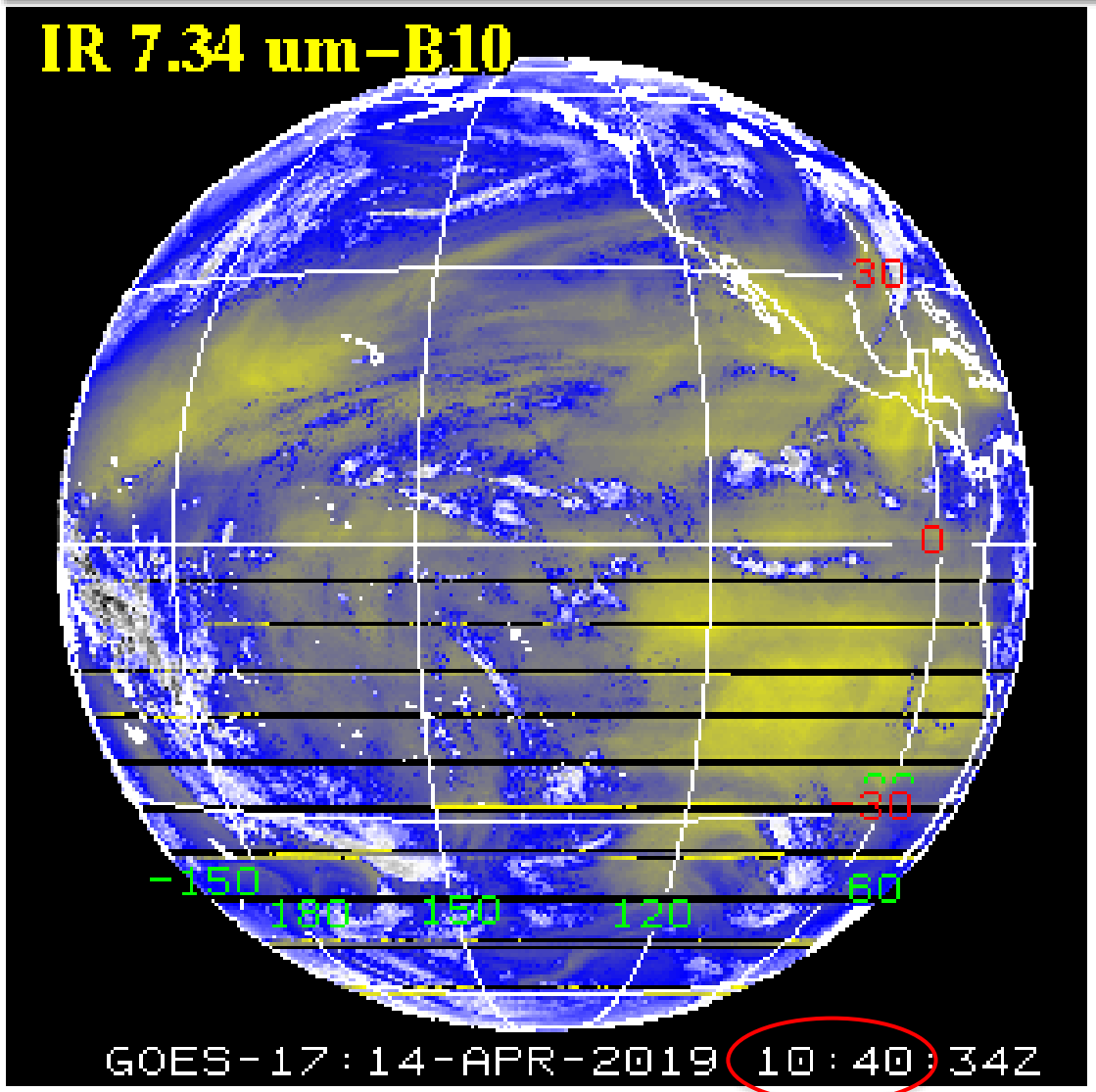


- Similar as LWIR FPM.
- No 2020 Prediction (without cooling).

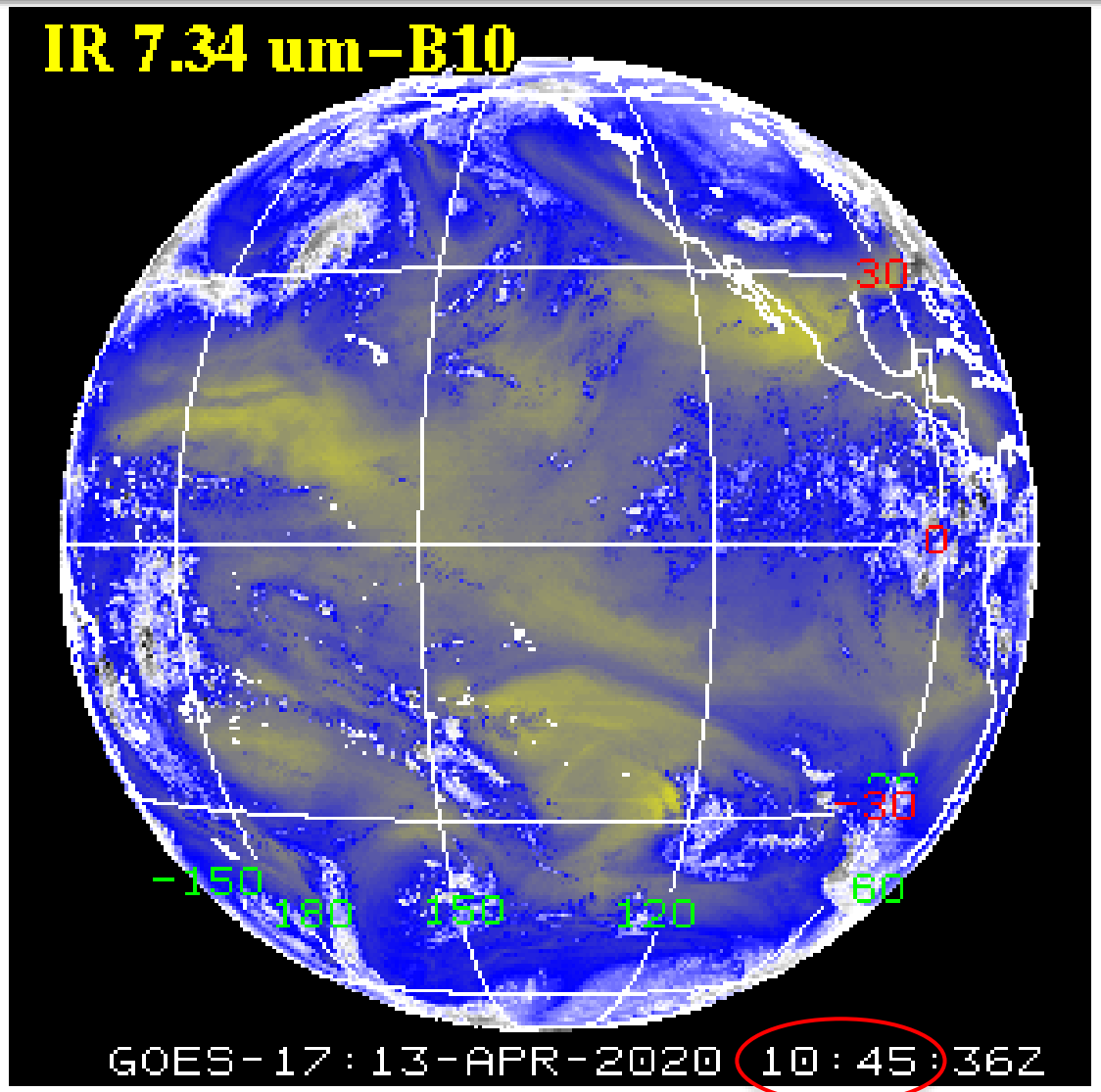
IMPACT ON IMAGERY

Evaluation by Human

2019 Day 104

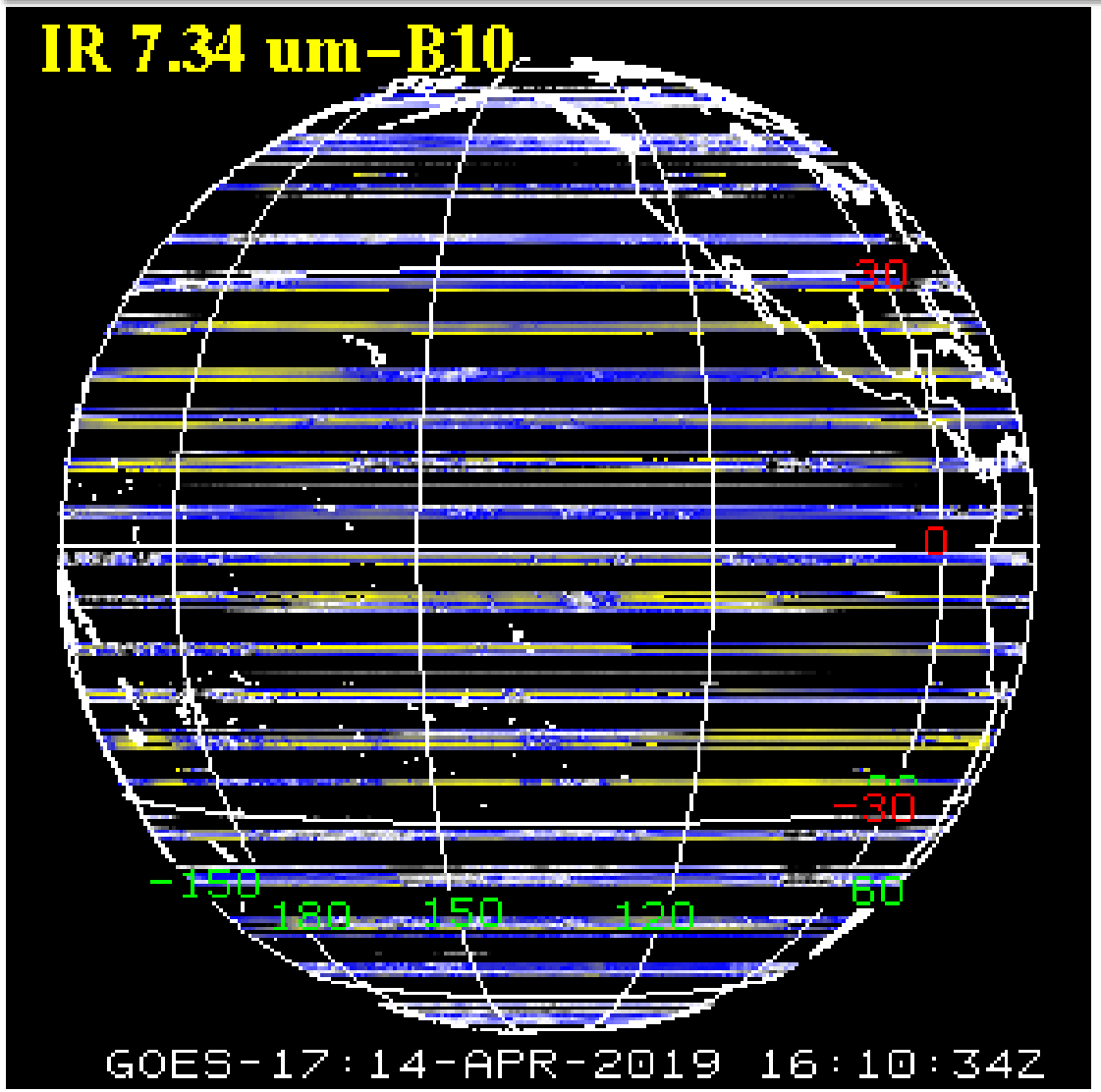


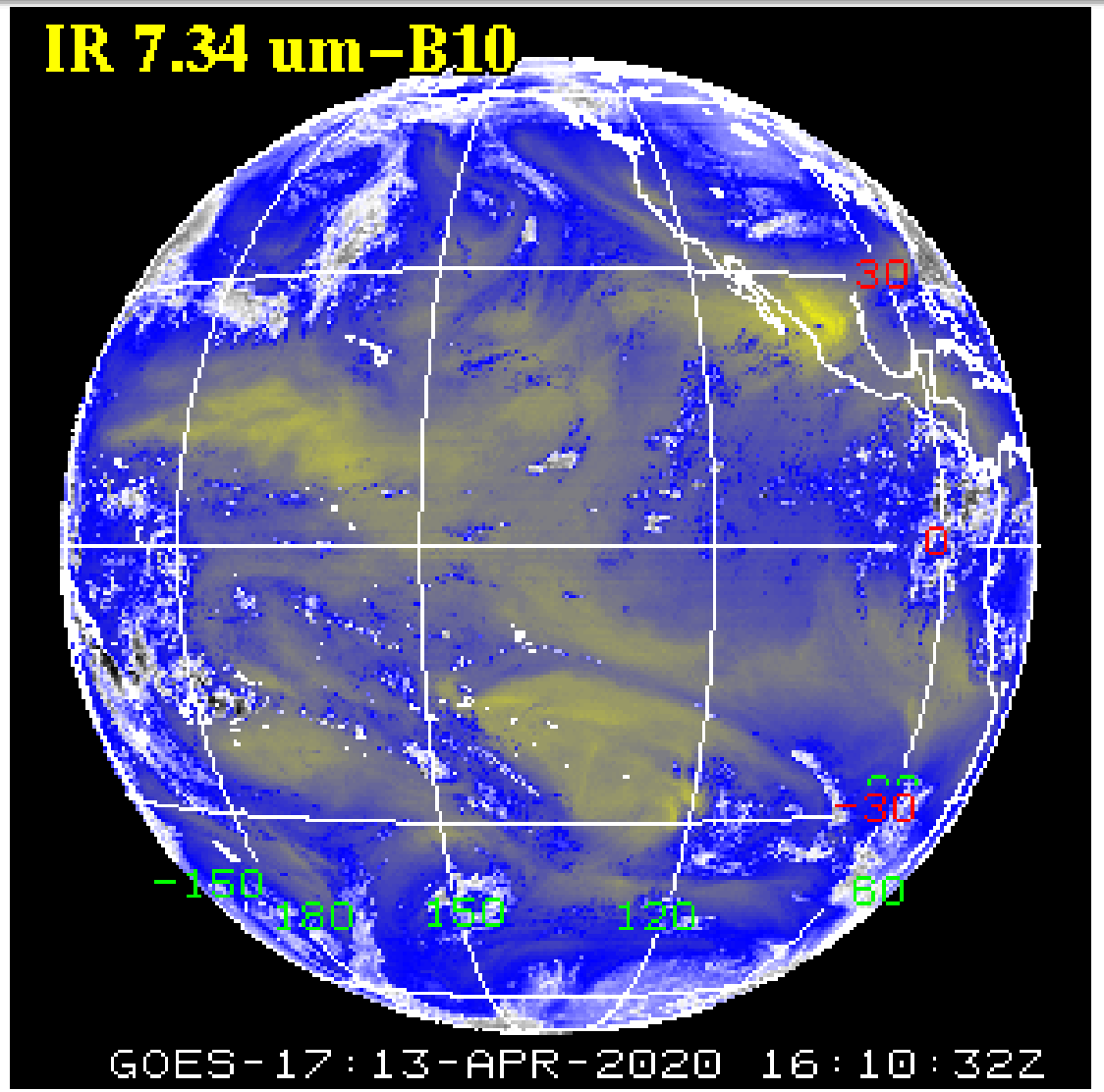
2020 Day 104



On the same day, good image ended by 10:40 in 2019 but continued after 10:45 in 2020, ...

2019 Day 104 Evaluation by Human 2020 Day 104

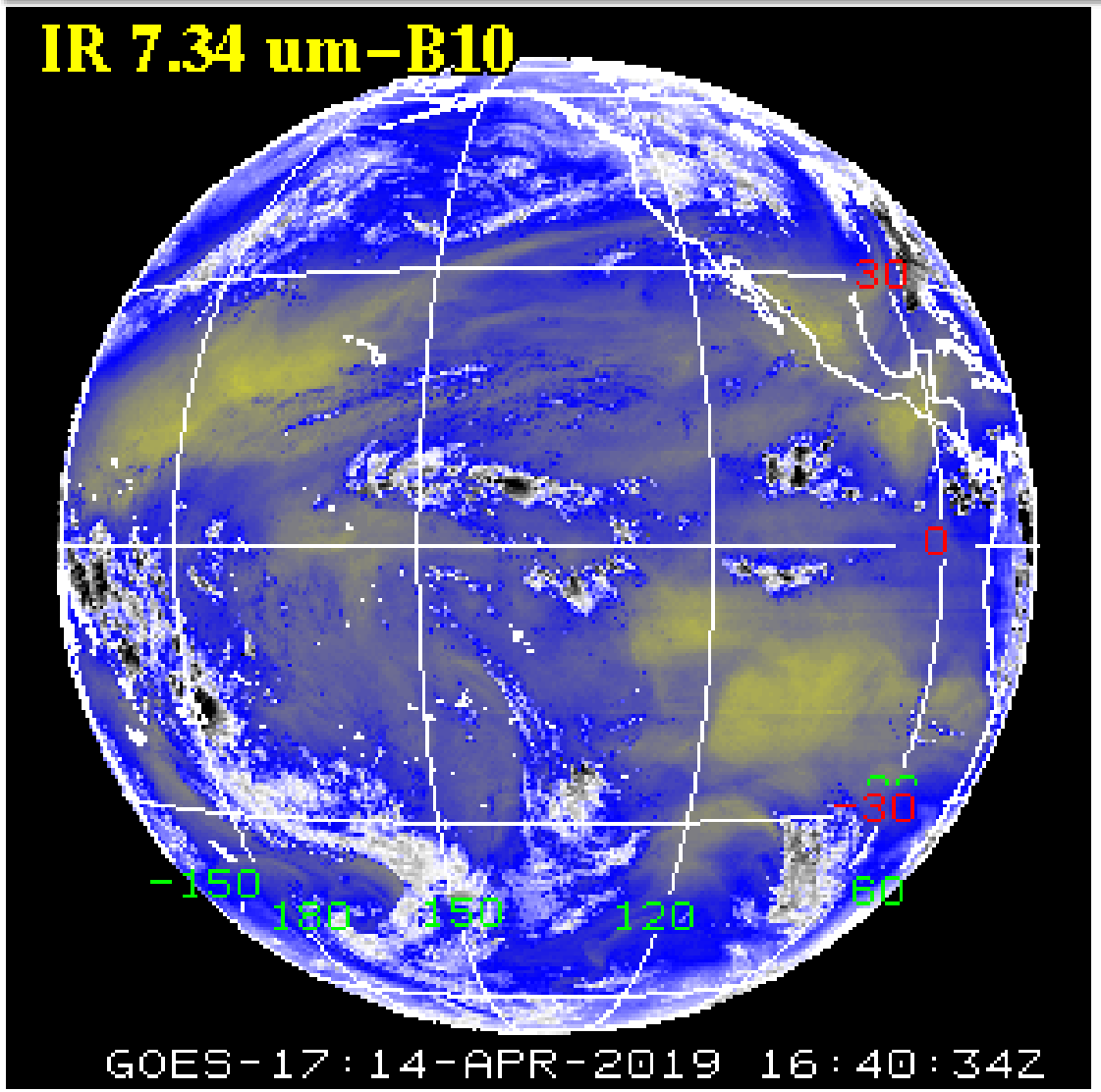




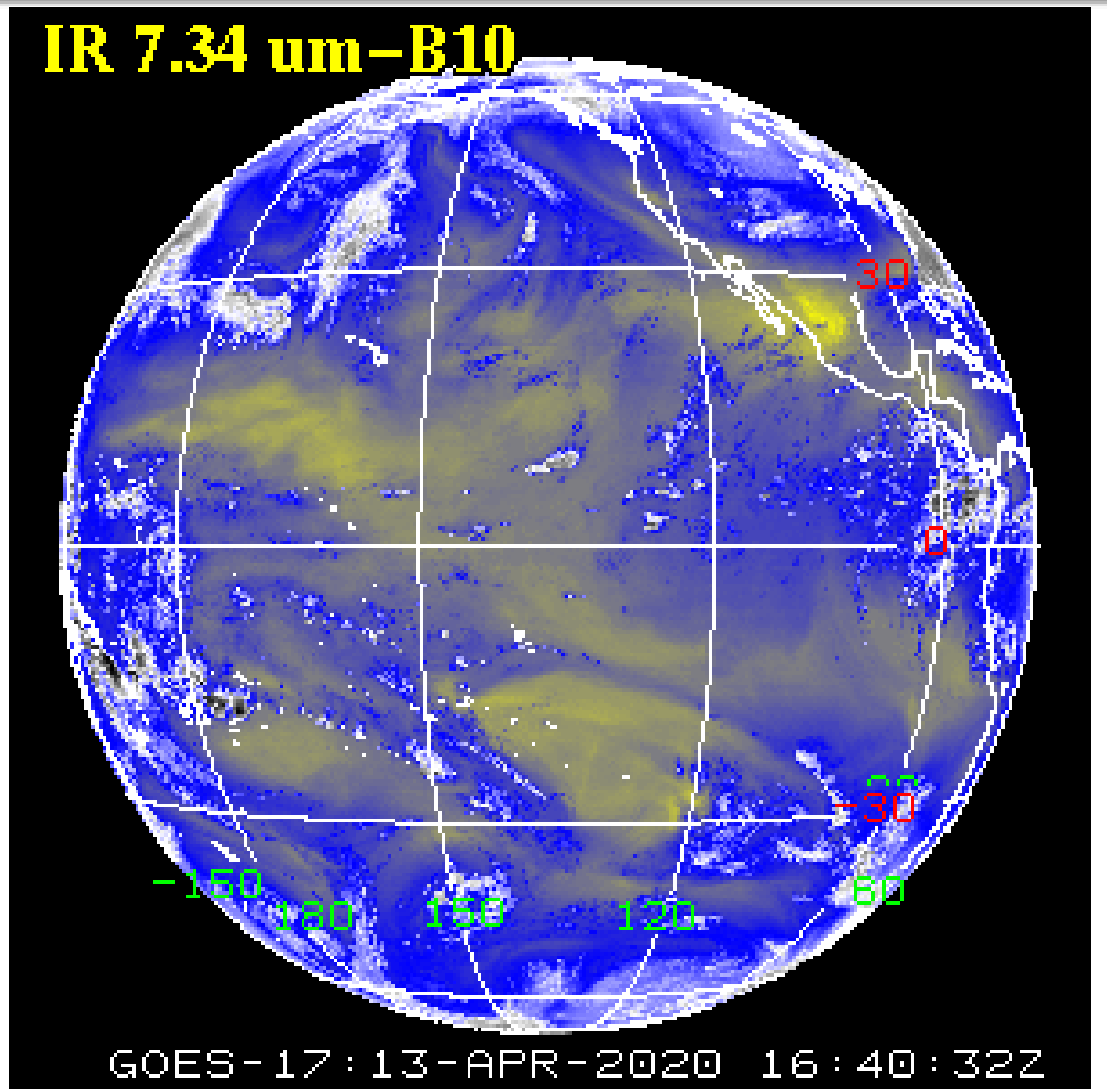
… and resumed by 16:10 in 2020 but not in 2019 …

Evaluation by Human

2019 Day 104



2020 Day 104



… Until 16:40. Cooling gained **1** more FD image before saturation and **3** more FD images after saturation.

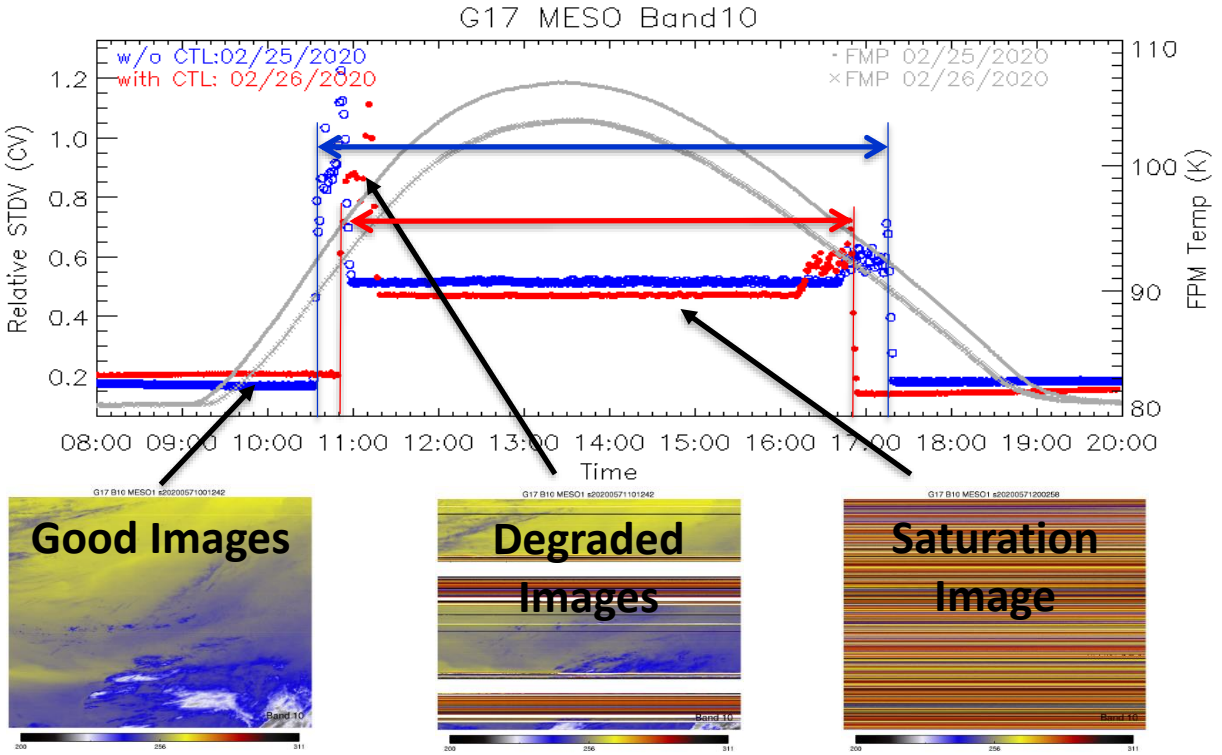
Evaluation by Algorithm

- Inspect all images of all channels everyday.
- "Coefficient of Variation" (CV) detects sudden change of image quality.

$$CV = \frac{standard\_deviation(radiance)}{mean(radiance)}$$

CV on a day **without** and **with** Cooling timeline.

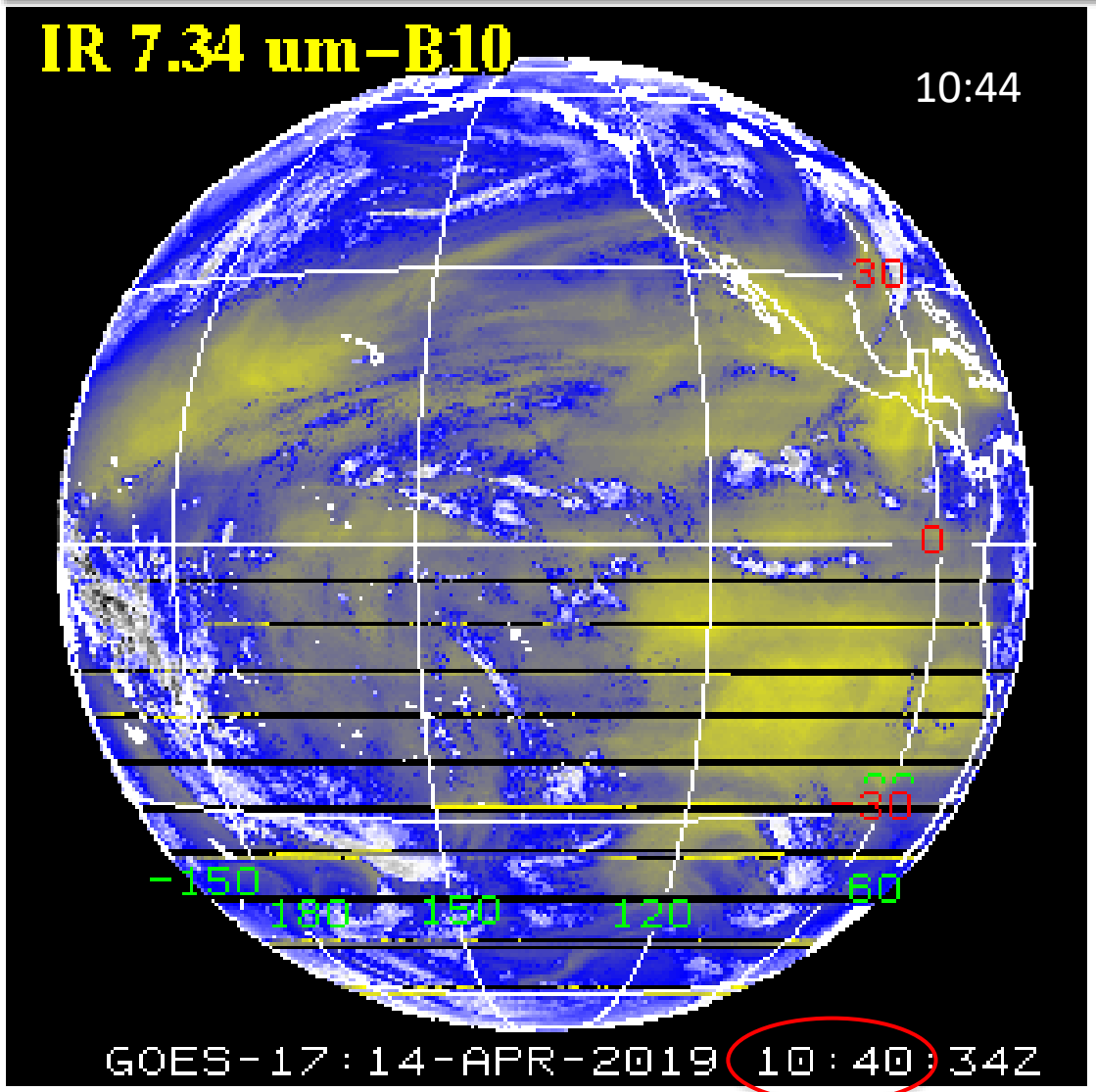
The value of CV is less relevant than its change.



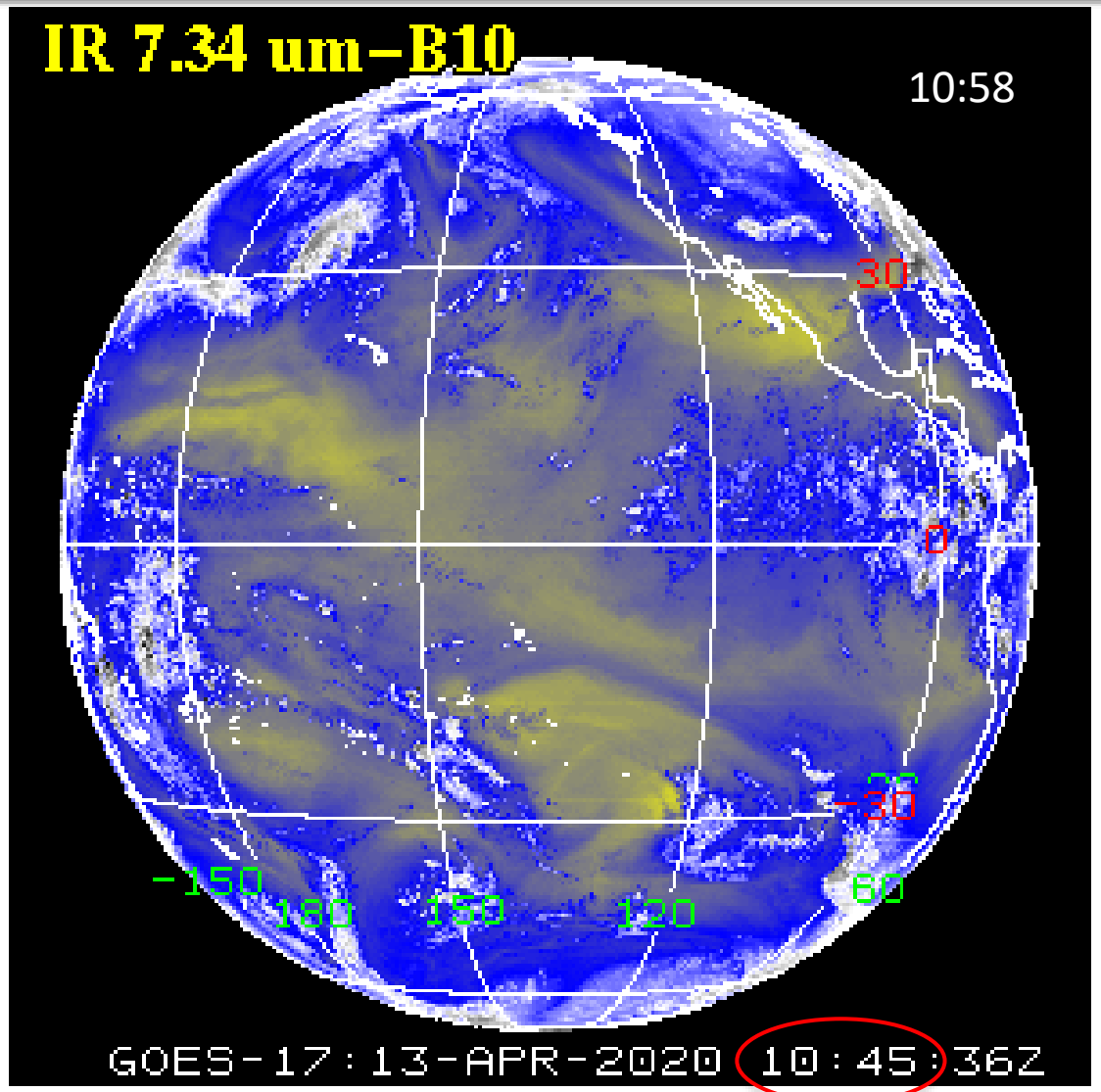
- Period of lost imagery without cooling.
- Reduced period of lost imagery with cooling.

Verification

2019 Day 104

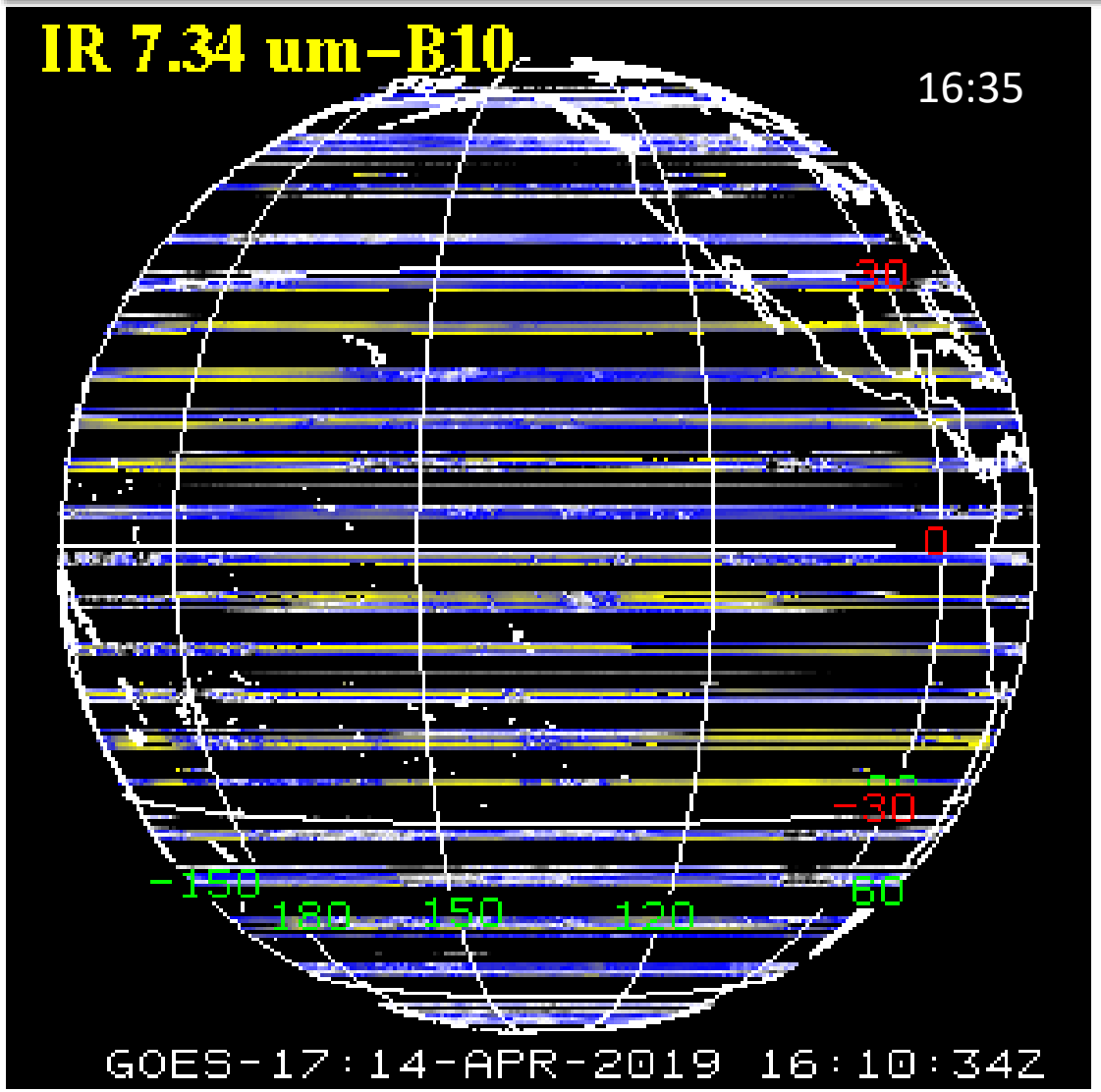


2020 Day 104

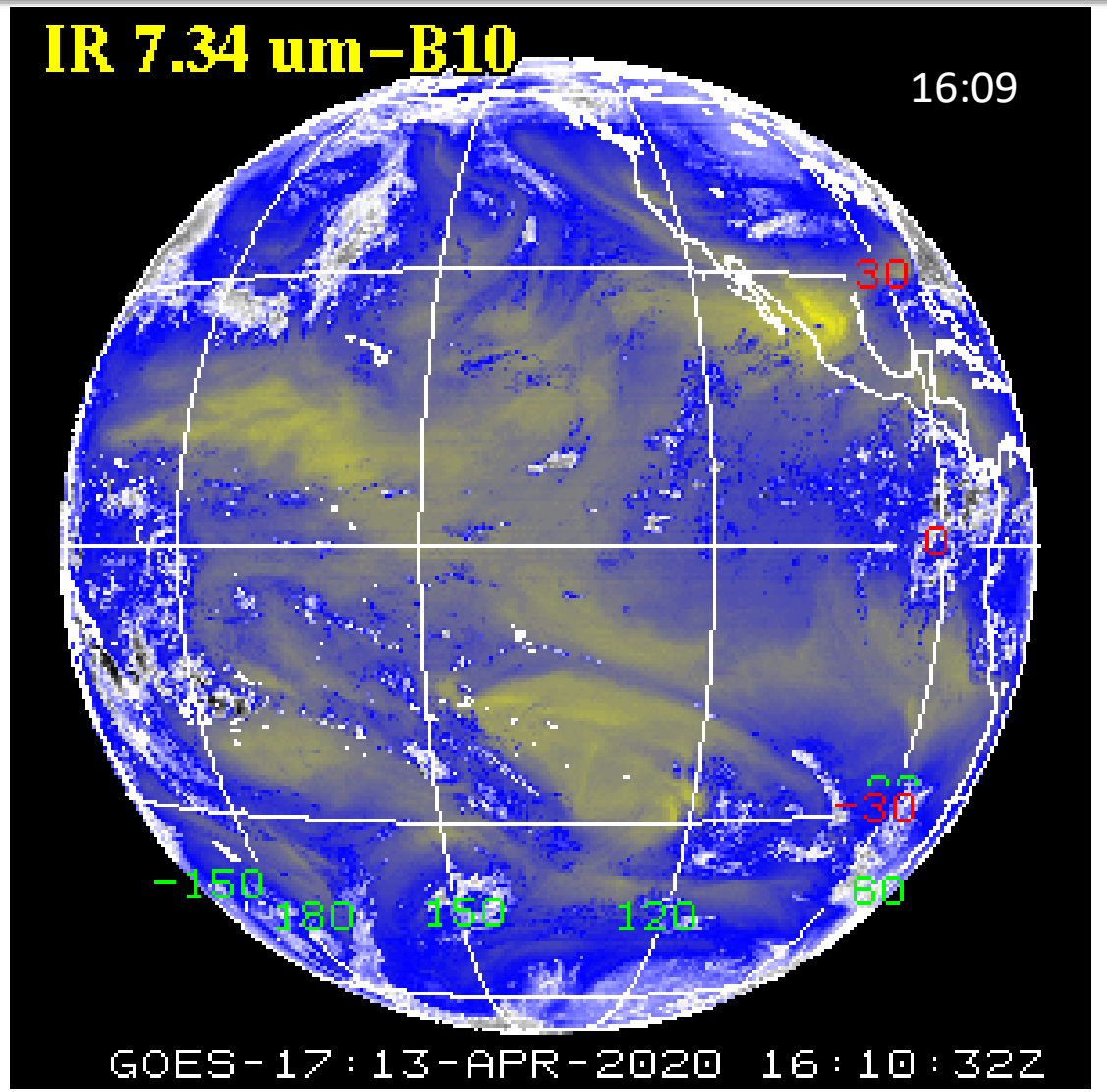


Verification

2019 Day 104

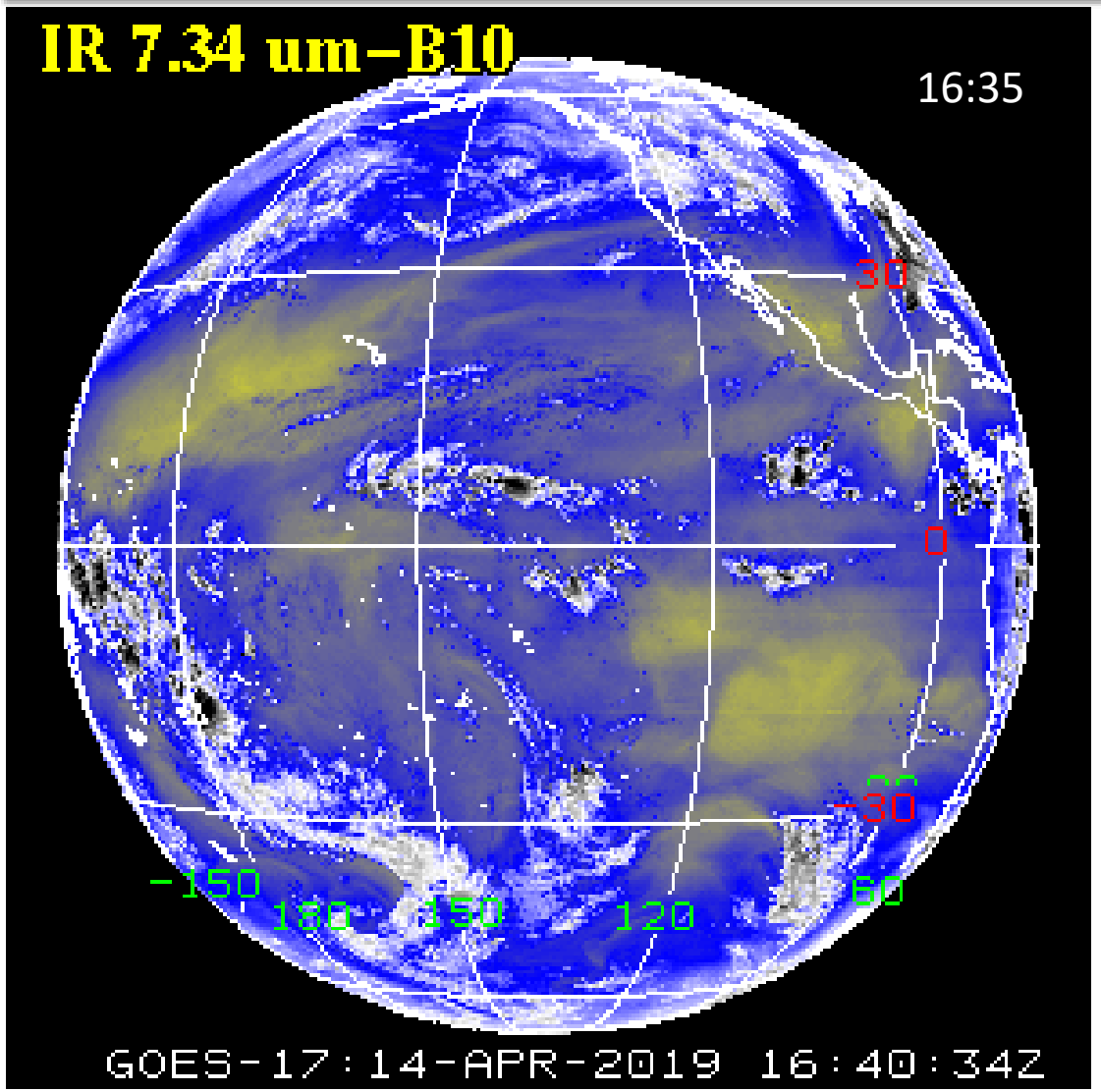


2020 Day 104

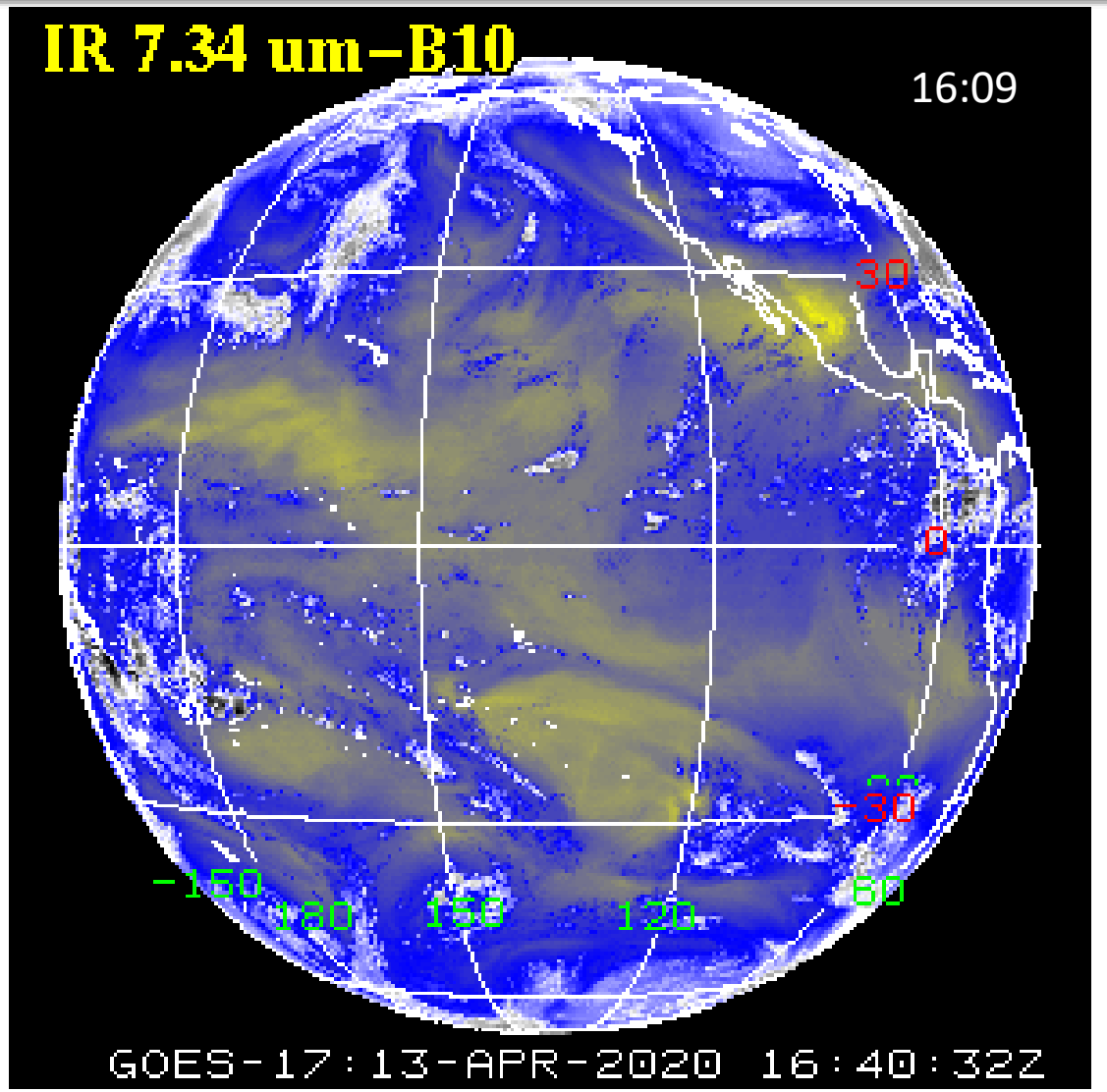


Verification

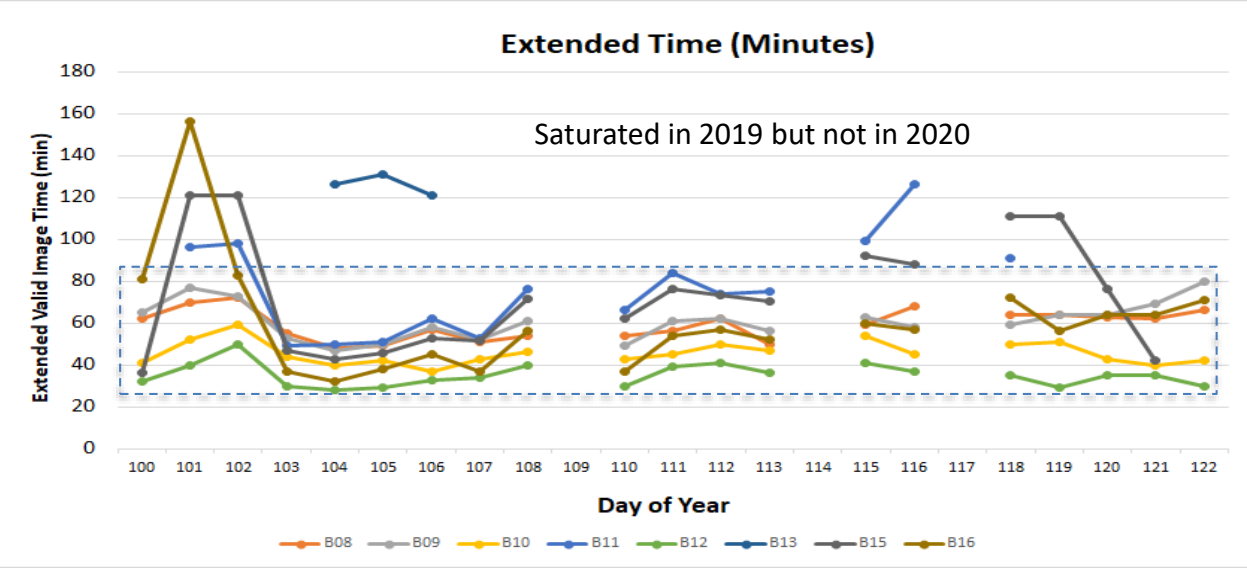
2019 Day 104



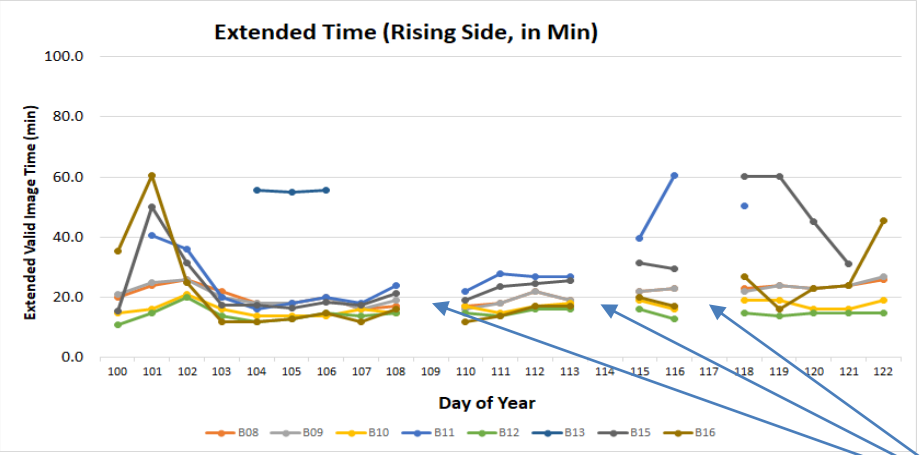
2020 Day 104

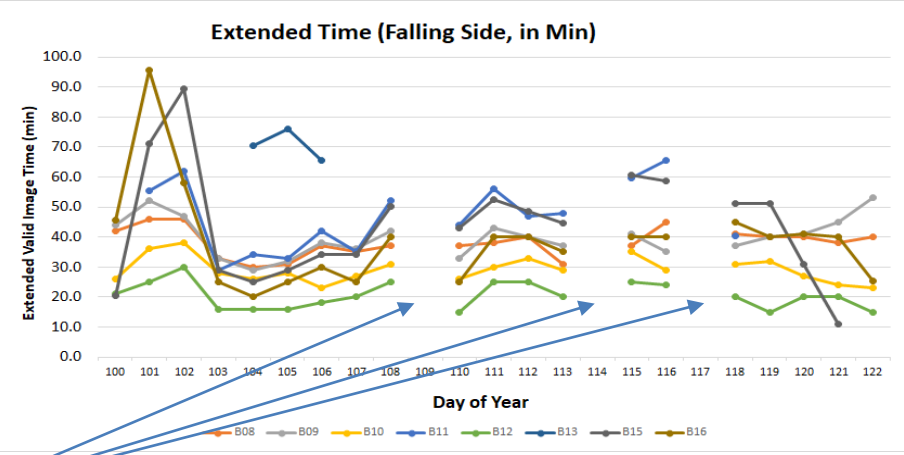


Results – More Time



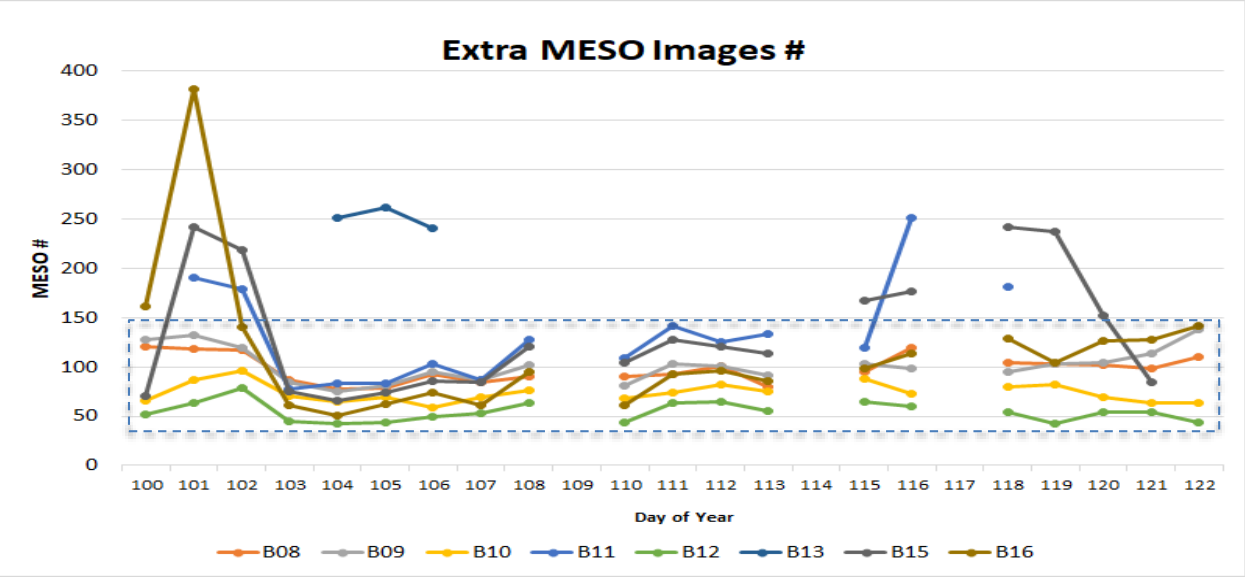
- 30 – 90 minutes (half to one and one half hour) for most channels on most days.
  - A lot more when it did not saturate with cooling but would without.
- More benefits after saturation.
  - FPM Temperature changes faster during heating than cooling.



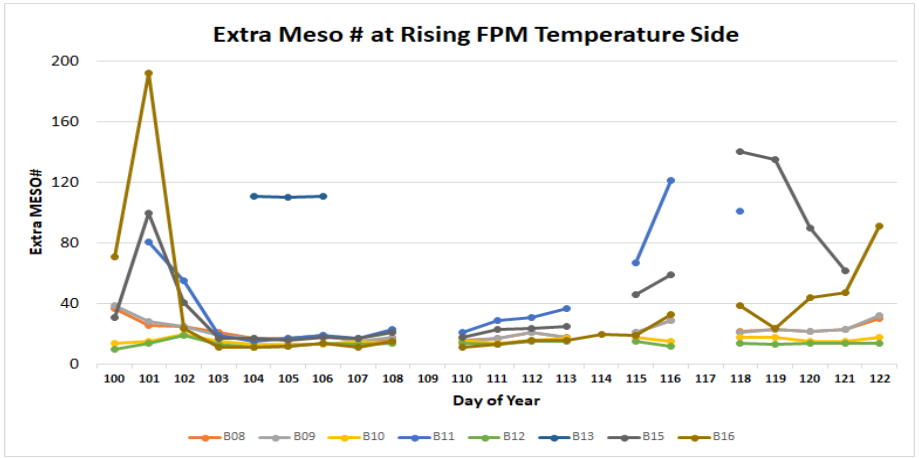


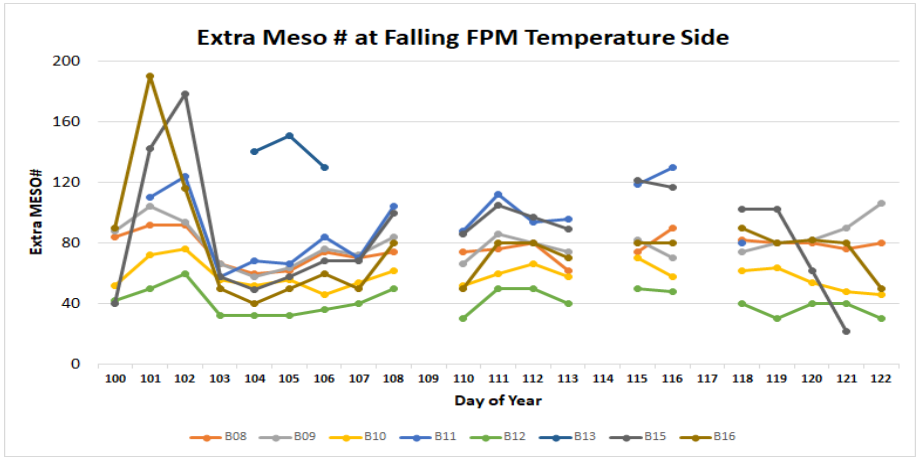
Incomplete MESO images disseminated at PDA on 04/18/2019, 04/23/2019 and 04/26/2019

Results – More MESO

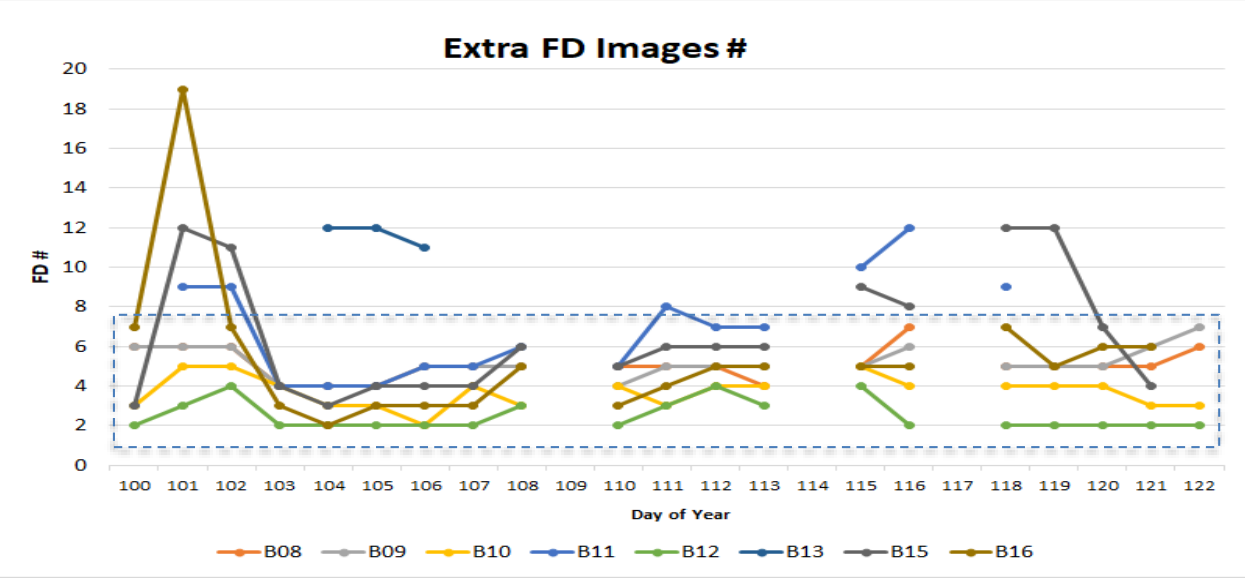


- 50 – 150 more MESOs for most channels on most days.
  - A lot more when it did not saturate with cooling but would without.
- More benefits after saturation.
  - FPM Temperature changes faster during heating than cooling.
  - One MESO per minute before saturation and four after.

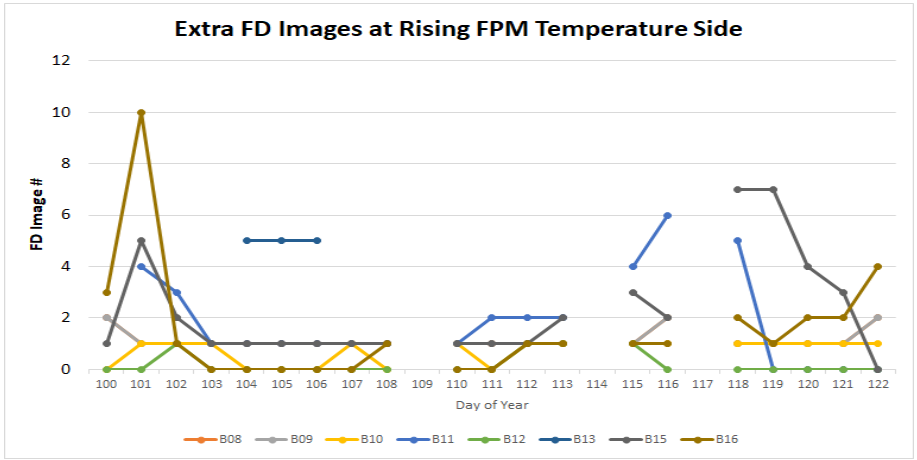


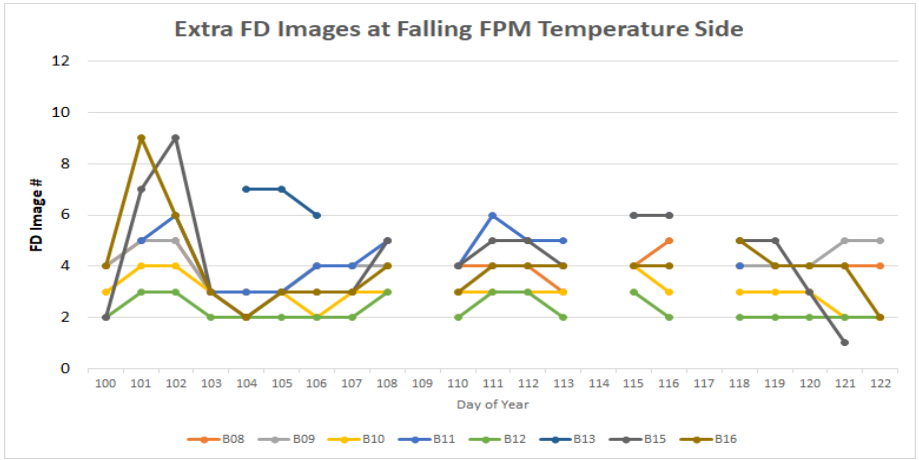


Results – More FD

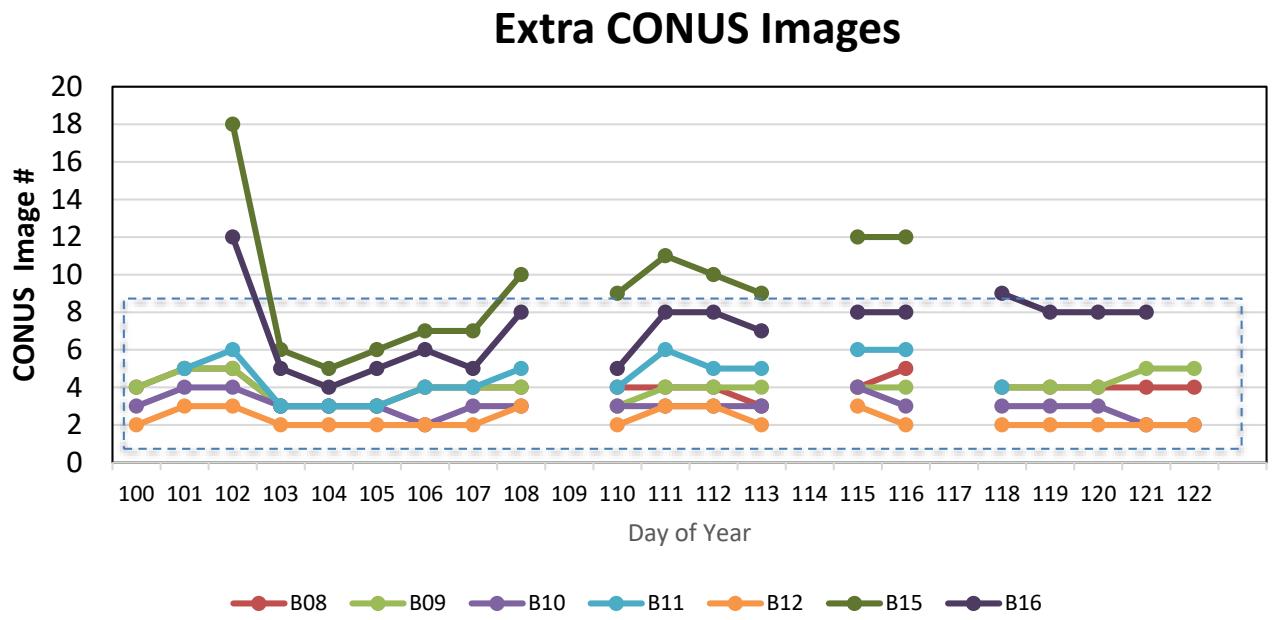


- 2 – 6 more FDs for most channels on most days.
  - A lot more when it did not saturate with cooling but would without.
- More benefits after saturation.
  - FPM Temperature changes faster during heating than cooling.
  - Four FDs per hour before saturation and six after.



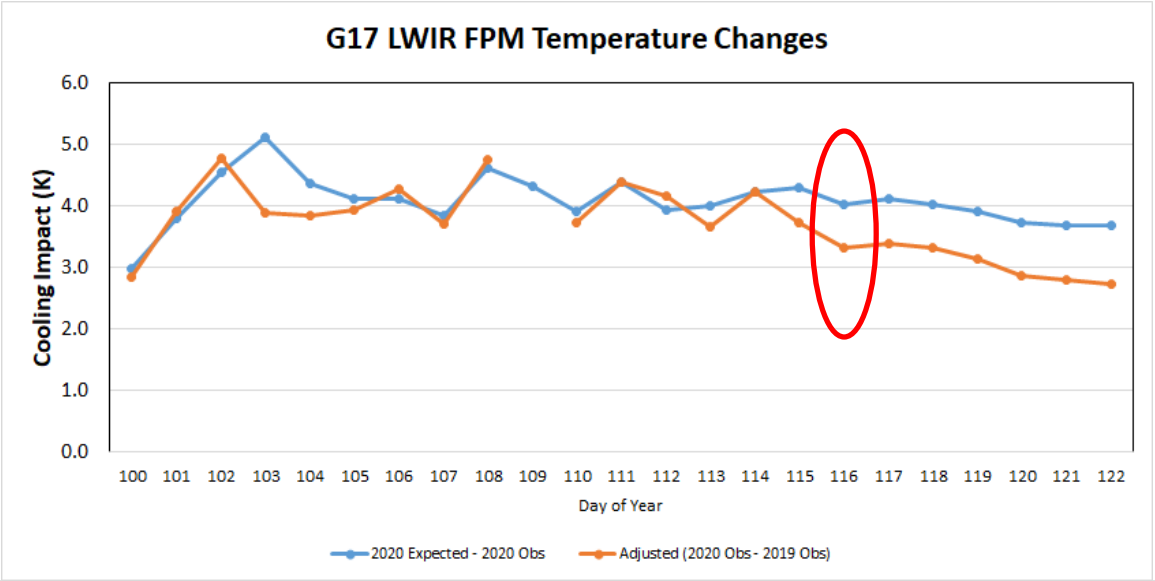


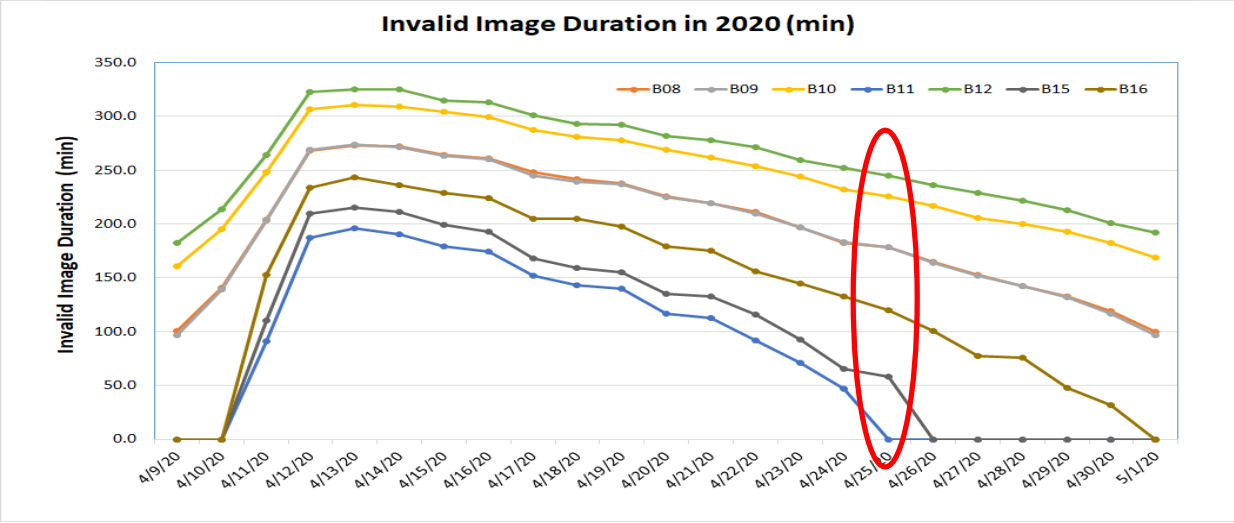
Results – More CONUS



- 2 – 8 more CONUS for most channels on most days.
  - A lot more when it did not saturate with cooling but would without.
- All CONUS are gained after saturation.

Results – Impact of Shorter Cooling





- On April 25, the cooling was shortened by 30 minutes (Mode 6 started at 1130 UTC instead of 1200 UTC) to resolve an operation conflict.
- LWIR FPM temperature is ~0.2K warmer than ending at 1200 UTC (estimate).
- Period of lost imagery for B15 increased by ~25 minutes than ending at 1200 UTC (estimate).
- Negligible impact for B08 and B09. No impact for B10, B12, and B16. Cannot assess for the other four bands.

Summary

- NOAA implemented a "Cooling Timeline" for GOES-17 ABI during the eclipse season to shorten the period of lost imagery by slowing down the FPM heating.
- It was tested in Feb and used in operation in April.
- We found that the Cooling Operation:
  - Reduced the daily peak FPM temperature by ~4K.
    - Slightly larger reduction on warmer days.
  - Had no impact on B07 and B14.
  - Shortened the period of lost imagery by 30–90 minutes. For most channels and on most days, that means 50 – 150 MESO images, 2 – 8 CONUS images, and 2 – 6 FD images.
    - A lot more when a channel would saturate without cooling but did not with cooling.
    - More benefits during the period of daily cooling than heating.
  - The FPM temperature was ~0.2K warmer on April 25 when the cooling was shortened by 30 minutes. The impact was minor for one channel, negligible for two channels, non-detectable for three channels, and cannot be assessed for four channels.
- We found no surprise nor unresolved issues.